FINAL MEETING SUMMARY
Discussion of Per- and Polyfluoroalkyl Substances (PFAS) Detections in Groundwater in the Vicinity of Former Marine Corps Air Station El Toro

Meeting Location: Irvine Ranch Water District (IRWD) Operations Center
Meeting Date/Time: 29 March 2018/1300–1410

Meeting Attendees:

Guy Chammas (U.S. Department of the Navy [Navy])
Arseny Kalinsky (IRWD)
Marc Smits (Navy)
Crispin Wanyoike (AECOM)
David Li (AECOM)
Kevin Burton (IRWD)
Alex Murphy (IRWD)
Alex Bollweg (Navy)
Roy Herndon (Orange County Water District [OCWD])
Lars Oldewage (IRWD)
Malcom Cortez (IRWD)
Carl Spangenberg (IRWD)
Jim Callian (Navy [via phone])
Patrick Versluis (OCWD)
Lyndy Lewis (IRWD)

Introductions and Presentation:

Mr. Marc Smits (Navy BRAC Environmental Coordinator) welcomed everyone to the PFAS meeting between the Navy, IRWD, and OCWD. Mr. Smits introduced Mr. Guy Chammas (Navy Lead Remedial Project Manager), who provided the attached presentation on PFAS Detections in Groundwater in the Vicinity of Former Marine Corps Air Station El Toro.

Mr. Chammas provided a PFAS background, including nomenclature, sources, chemical properties, and current regulations. He then presented the results of PFAS sampling events OCWD performed in July, August, and October 2016. These results indicated certain PFAS compounds were present in the influent from the Navy's Shallow Groundwater Unit (SGU) extraction and conveyance system associated with Former Marine Corps Air Station (MCAS) El Toro Installation Restoration Program (IRP) Site 24 to IRWD's SGU Treatment Plant and in Principal Aquifer (PA) groundwater extracted from extraction well ET-1 associated with IRP Site 18. The results for extraction well ET-1 indicated that the existing air stripping/vapor-phase granular activated carbon (GAC) treatment system was not removing PFAS from groundwater.

Mr. Chammas then presented results from the Navy's basewide PFAS investigation that was completed for IRP Sites 1, 2, 5, 9, 16, 18, and 24 at Former MCAS El Toro in July 2017. He noted that the Navy obtained very similar results to those obtained by OCWD for the extracted groundwater at the SGU (IRP Site 24).

Mr. Chammas then discussed the stipulations of the Settlement Agreement between the Navy and IRWD/OCWD regarding the remediation of SGU and PA groundwater impacted by volatile organic compounds. The Navy issued PFAS notification letters to the BRAC Cleanup Team and IRWD/OCWD on 26 October 2017. The existing SGU and PA treatment systems, consisting of air stripping and vapor-phase GAC, do not effectively treat PFAS. If the treatment train was modified to liquid-phase GAC, it may be more effective in removing PFAS from groundwater. Mr. Chammas also mentioned that there are currently no detections in drinking water and there are no legally enforceable human-health or ecological-based standards, but such standards would likely be developed in the future. Mr. Chammas indicated that Mr.

Murphy (IRWD) previously contacted him about proposing an as-needed diversion of treated SGU effluent to the Michelson Water Recycling Plant. Mr. Chammas indicated that he was concerned that this may be problematic considering that PFAS were not being effectively treated in the groundwater. This raised the issues of potential additional treatment, IRWD's/OCWD's policies regarding PFAS, and regulatory compliance. Mr. Chammas finished the presentation by discussing the potential end-user exposures from PFAS-impacted groundwater such as terrestrial, marine, and recycled water.

Discussion:
The Navy, IRWD, and OCWD discussed PFAS issues following the presentation. Some of the more important subjects discussed are listed below:

- The new groundwater model update showed possible historical flow paths toward potable water well (b) (9) . This could be cause for concern. However, Mr. Versluis (OCWD) indicated that that well had been previously sampled with no PFAS detections. Mr. Chammas asked Mr. Versluis to forward the data to the Navy for its records.
- Discharge from the SGU Treatment Plant is currently to the regional brine line and eventually the Pacific Ocean. Although there are no current ecological screening levels, it is likely they will be developed in the future
- The participants agreed that it was important to sample the other PA extraction wells associated with IRP Site 18 (ET-2 and IRWD-78). OCWD agreed to make such sampling a priority.
- The Navy suggested that sampling of monitoring well 18BGMW19, which contains a total of 5 ports in the SGU and PA and is located between the SGU Treatment Plant and production well (b) (9) , would be prudent and would look into collecting such samples.
- The existing treatment systems do not adequately treat PFAS, and other options might need to be addressed. Liquid-phase GAC is an option that both the Navy and IRWD previously considered; the GAC will need to be treated for PFAS after it is spent. The temperature at which the carbon-fluorine bond could be broken is relatively high and may be problematic and/or expensive. There is a GAC regeneration plant in Texas that Mr. Wanyoike (AECOM) mentioned could be used.
- There are currently no PFAS results for the recycled water system.
- The Navy, IRWD, and OCWD decided to discuss the PFAS issues with their respective legal counsels and reconvene in 2 to 3 months.

Action Items:
- OCWD to submit results from previous sampling of production well (b) (9) to the Navy.
- OCWD to prioritize sampling of PA extraction wells ET-2 and IRWD-78 for PFAS analysis.
- Navy, IRWD, and OCWD to discuss Settlement Agreement stipulations with respective counsels.
- Navy to consider sampling monitoring well 18BGMW19 for PFAS analysis.
- Navy to identify possible dates to reconvene for additional discussion.

Naval Facilities Engineering Command

FORMER MARINE CORPS AIR STATION EL TORO

Discussion of Per- and Polyfluoroalkyl Substances (PFAS) Detections in Groundwater in the Vicinity of Former Marine Corps Air Station El Toro

Guy Chammas, MS, PG, CPSS, Lead Remedial Project Manager
Marc Smits, PE, BRAC Environmental Coordinator
Alex Bollweg, Environmental Engineering Support
U.S. Department of the Navy (Navy)
Base Realignment and Closure (BRAC) Program Management Office West

29 March 2018

PFAS Background

- **Nomenclature**
  - –Use of “PFAS” preferred over “PFC”
  - –Perfluoroalkyl substances are fully fluorinated (C–F bond very strong)
  - –Polyfluoroalkyl substances are partially fluorinated (more degradable)
  - –Perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorobutane sulfonic acid (PFBS)
- **Sources**
  - –Manufacturing
    - Textiles, leather, paper products, metal plating, etc.
  - –Consumer Products
    - Nonstick cookware, carpet, waterproof clothing, dental floss, etc.
  - –Burn Areas/Firefighting Training Areas
  - –Wastewater Treatment Plants
- **Properties**
  - –High solubility
  - –Low partition coefficient
  - –Low volatility
  - –Primarily anionic (PFOS and PFOA are relatively strong acids)
  - –Thermally and chemically stable

PFAS Background (cont.)

- **Regulations**
  - –Not a Comprehensive Environmental Response, Compensation, and Liability Act hazardous substance
  - –No promulgated drinking water, human health, or ecological standards at state or federal level (other states have promulgated values)
  - –United States Environmental Protection Agency (U.S. EPA) Lifetime Health Advisories (LHAs) for PFOA, PFOS, PFOA+PFOS are 0.07 micrograms per liter (µg/L)
  - –U.S. EPA Regional Screening Level (RSL) for PFBS is 400 µg/L

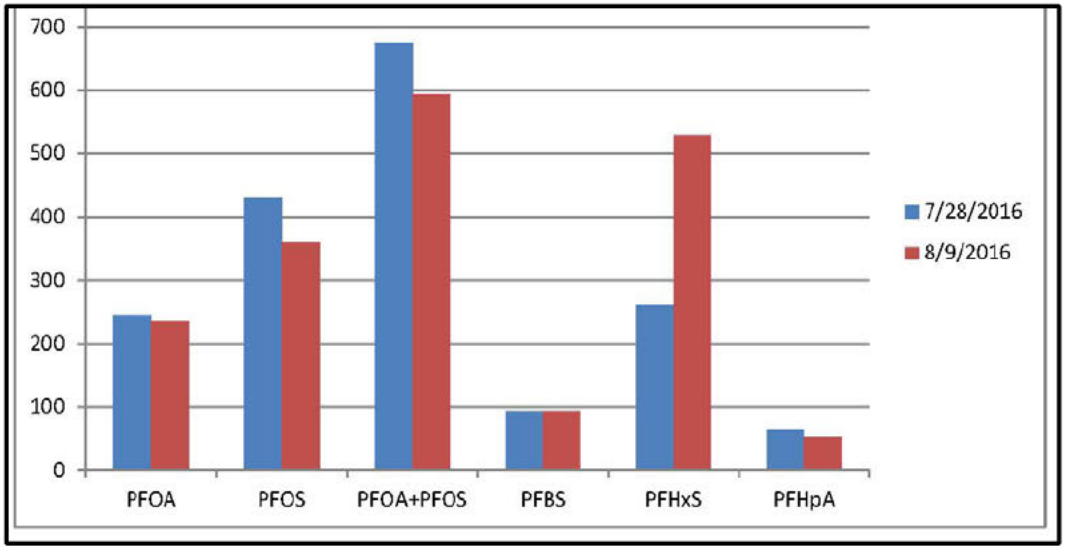
Water District Sampling Results

- Local drinking water not impacted based on U.S. EPA Unregulated Contaminant Monitoring Rule 3 sampling and analysis (2013, 2014)
- Shallow Groundwater Unit (SGU) Treatment Plant influent sampled twice in 2016

		Method 537 Analysis						
Site ID	Sample Date	PFOA	PFOS	PFOA+PFOS	PFBS	PFHxS	PFHpA	PFNA
SGU INFLUENT - El Toro MCAS	7/28/2016	**244**	**430**	**674**	**94**	**260**	**64**	ND
SGU INFLUENT - El Toro MCAS	8/9/2016	**235**	**359**	**594**	**93**	**527**	**52**	ND

Notes:

1. Units are parts per trillion (ppt)
2. PFOA, PFOS, PFOA+PFOS LHA is 70 ppt
3. PFBS RSL is 400,000 ppt
4. Detections are bolded
5. Exceedences are highlighted in yellow



Water District Sampling Results (cont.)

- Principal Aquifer groundwater at extraction well ET-1 sampled in 2016
  - –Pre-treatment (ET-1/1)
  - –Post-treatment (VOC-ET1-WETWELL)

Site ID	Sample Date	PFOA	PFOS	PFOA+PFOS	PFBS	PFHpA	PFHxS
ET - 1/1	10/19/2016	**227**	**38.2**	**265**	**7.0**	**9.4**	**89.6**
VOC-ET1-WETWELL	10/19/2019	**233**	**35.8**	**269**	**6.8**	**9.3**	**87.5**

Notes:

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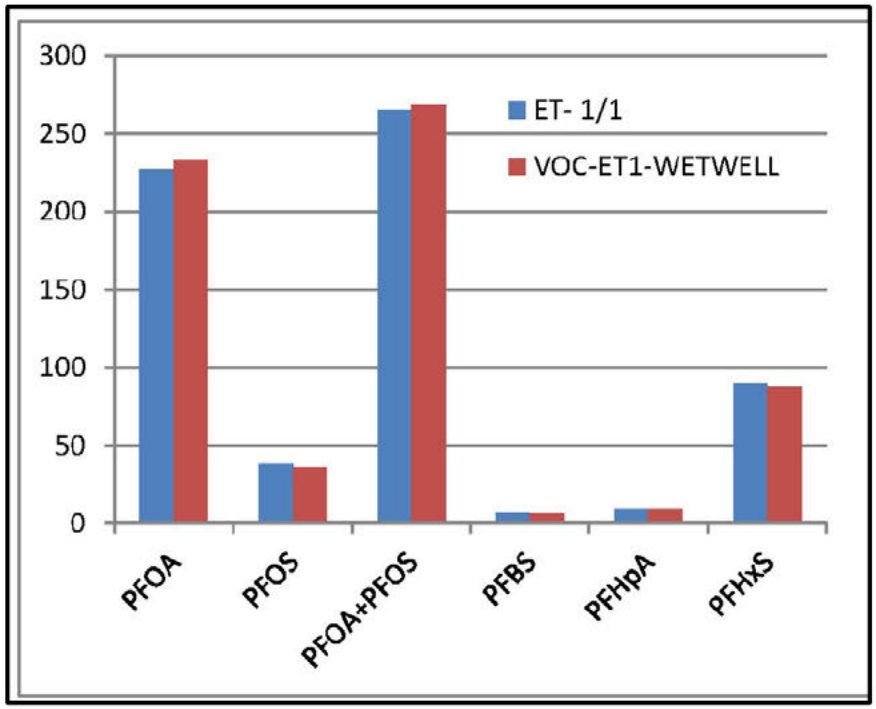
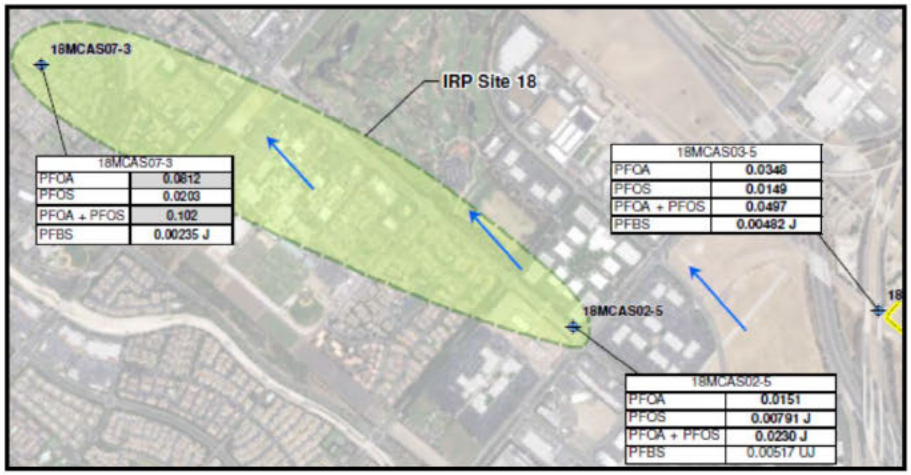


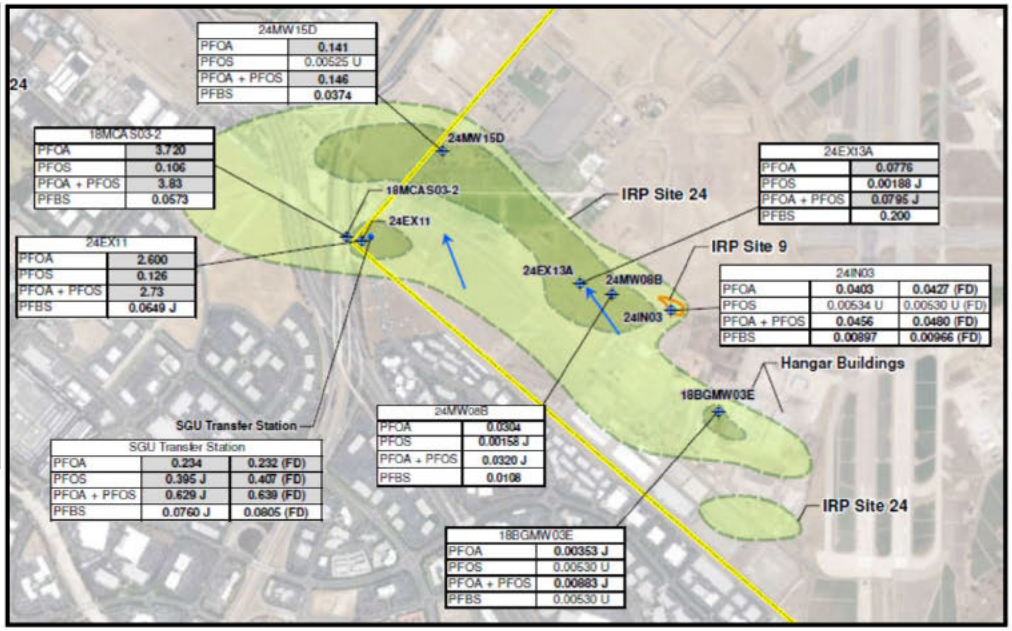
Navy Sampling Results

- Potential PFAS source areas screened in desktop analysis
- Installation Restoration Program (IRP) Sites 1, 2, 5, 9, 16, 18, 24 sampled
  - –22 primary and 3 duplicate samples collected in July 2017
- PFOS and/or PFOA detected at concentrations exceeding LHA at IRP Sites 1, 18 (Principal Aquifer), and 24 (SGU)

IRP SITE 18



IRP SITE 24



Navy Sampling Results (cont.)

Table 6
Groundwater Analysis - PFOA, PFOS, and PFBS Results

	Screened Interval	Sample Date	PFOA	PFOS	PFOA + PFOS	PFBS
			µg/L			
	Screening Criterion		0.07 [1]	0.07 [1]	0.07 [1]	400 [2]
IRP Site 18 (PA)						
18MCAS07-3	350-360	7/10/2017	**0.0812**	**0.0203**	**0.102**	**0.00235 J**
18MCAS02-5	420-430	7/10/2017	**0.0151**	**0.00791 J**	**0.0230 J**	0.00517 UJ
18MCAS03-5	420-430	7/10/2017	**0.0348**	**0.0149**	**0.0497**	**0.00482 J**
IRP Sites 9 and 24 (SGU)						
24IN03	140-160	7/12/2017	**0.0403**	0.00534 U	**0.0456**	**0.00897**
DUP02 (Parent: 24IN03)	140-160	7/12/2017	**0.0427**	0.00530 U	**0.0480**	**0.00966**
24MW08B	160-170	7/10/2017	**0.0304**	**0.00158 J**	**0.0320 J**	**0.0108**
24EX13A	145-165	7/12/2017	**0.0776**	**0.00188 J**	**0.0795 J**	**0.200**
24MW15D	220-230	7/12/2017	**0.141**	0.00525 U	**0.146**	**0.0374**
24EX11	195-215	7/10/2017	**2.600**	**0.126**	**2.73**	**0.0649 J**
SGU Transfer Station	N/A; effluent sample	7/10/2017	**0.234**	**0.395 J**	**0.629 J**	**0.0760 J**
DUP03 (Parent: SGU Transfer Station)	N/A; effluent sample	7/10/2017	**0.232**	**0.407**	**0.639**	**0.0805**
18BGMW03E	124-164	7/12/2017	**0.00353 J**	0.00530 U	**0.00883 J**	0.00530 U
18MCAS03-2	160-170	7/10/2017	**3.720**	**0.106**	**3.83**	**0.0573**

Navy Sampling Results (cont.)

- IRP Site 18 had marginal exceedances only at furthest downgradient well (additional non-Navy source?)
- IRP Site 24 had highest detections (up to 3.83 µg/L) along base border
- SGU results from Water Districts and Navy very similar
  - –Water District: PFOA+PFOS = 0.634 µg/L (average of 2 samples)
  - –Navy: PFOA+PFOS = 0.634 µg/L (average of primary and duplicate)
- PFBS was not detected at concentrations greater than RSL

Settlement Agreement Stipulations

- Notification
  - –Separate notification letters to BRAC Cleanup Team and Water Districts on 26 October 2017
  - –Final Technical Memorandum to stakeholders in November 2017
- Existing treatment operations, responsibility, and effectiveness
  - –Joint determination of ability to meet applicable federal/state standards
    - No detections in drinking water
    - Neither SGU or PA (IRP Site 18) water provided for potable purposes
    - No legally enforceable human-health or ecological-based standards currently, but likely to be developed in the future
  - –Air stripping/vapor-phase granular activated carbon not effective for PFAS
  - –Previously evaluated switching to liquid-phase granular activated carbon for treatment of groundwater

Settlement Agreement Stipulations (cont.)

- Groundwater ownership
- Proposed as-needed diversion of treated effluent to Michelson Water Recycling Plant
  - –Potential need for additional treatment?
  - –Water District policies/regulatory compliance?
- Potential end-user exposures
  - –Terrestrial
  - –Marine
  - –Purple water
  - –Previously unimpacted areas (golf courses, new portions of Principal Aquifer, etc.)